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## ORIGINAL ARTICLE

**TO STUDY THE EFFECTIVENESS OF QUADRICEPS MUSCLE STRENGTHENING VS HAMSTRING MUSCLE STRENGTHENING IN PATIENTS WITH KNEE OSTEO ARTHRITIS**

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### ABSTRACT

**Background of the study:** Osteoarthritis (OA) is a chronic degenerative disease affecting major joints of the body especially weight-bearing joints. OA knee can be associated with symptoms of pain, instability, reduction of range of motion (ROM). The Quadriceps and Hamstrings muscles plays a crucial role in knee function and stability weakness or imbalance in these muscle groups can exacerbate knee OA symptoms and impair functional ability. While strengthening these muscles it works as a rehabilitation strategy for knee OA. Objective of the study is to compare the effect of quadriceps VS hamstring muscle strengthening on knee pain, range of motion, and function in patients with knee OA. **Methodology:** A group of 30 participants on the bases of inclusion and exclusion criteria was selected and divided into two groups A and B. This Study design is Quasi Experimental, and comparative study (pre and post intervention) type. Sampling method is Random sampling and conducted at Dr. MGR. University, Faculty of Physiotherapy with sample size of 30. Outcome Measurements were Pain, Range of motion, and Function of knee. Measuring Tool s are VAS (Visual analog scale), Goniometry, KOOS (knee Injury and Osteoarthritis outcome score). **Result:** Group A intervention found more effective over Group B intervention on VAS and KOOS with mean score difference of 3.20 and 19.20 over 2.87 and 16.73 respectively. **Conclusion:** Quadriceps strengthening or ideally, a combination of both can help enhance knee joint stability, reduce pain, and improve the quality of life in individuals with knee OA.

**Keywords:** Quadriceps strengthening, Hamstring strengthening, Pain, Osteoarthritis.

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## INTRODUCTION

Osteoarthritis is a common degenerative disorder of the articular cartilage associated with hypertrophic changes in the bone. Risk factors include genetics, female sex, past trauma, advancing age, and obesity. The most common symptom of osteoarthritis is joint pain. The pain tends to worsen with activity, especially following a period of rest; this has been called the gelling phenomenon. Osteoarthritis can cause morning stiffness, but it usually lasts for less than 30 minutes, unlike rheumatoid arthritis, which causes stiffness for 45 minutes or more<sup>1-3</sup>.

Knee osteoarthritis (OA), also known as degenerative joint disease, is typically the result of wear and tear and progressive loss of articular cartilage. It is most common in the elderly population<sup>4</sup>. Knee osteoarthritis can be divided into two types, primary and secondary. Primary osteoarthritis is articular degeneration without any apparent underlying reason. Secondary osteoarthritis is the consequence of either an abnormal concentration of force across the joint as with post-traumatic causes or abnormal articular cartilage, such as rheumatoid arthritis (RA)<sup>5</sup>.

Knee osteoarthritis is the most common type of arthritis diagnosed, and its prevalence will continue to increase as life expectancy and obesity rises. Depending on the source, roughly 13% of women and 10% of men 60 years and older have symptomatic knee osteoarthritis. Among those older than 70 years of age, the prevalence rises to as high as 40%<sup>6</sup>.

The prevalence of knee osteoarthritis in males is also lower than in females. Interestingly, not

everyone who demonstrates radiographic findings of knee osteoarthritis will be symptomatic. One study found that only 15% of patients with radiographic findings of knee OA were symptomatic. Not factoring in age, the incidence of symptomatic knee osteoarthritis is roughly 240 cases per 100,000 people per year<sup>(7)</sup>. Individuals with knee osteoarthritis have shown knee extensor muscle weakness compared to control subjects<sup>(8)</sup>. Individual studies have reported knee extensor muscle weakness to be a risk factor for knee osteoarthritis, particularly in women<sup>9</sup>.

In persons with symptomatic osteoarthritis of the knee, quadriceps muscle weakness is common and is widely believed to result from disuse atrophy secondary to Joint pain. Although the exercises are to strengthen the quadriceps may relieve joint pain in persons with osteoarthritis of the knee<sup>10</sup>. Elucidation of the role of muscle weakness in osteoarthritis is particularly important given our growing understanding of safe and effective methods for increasing strength in elderly persons<sup>11</sup>.

A study found that knee osteoarthritis significantly affects the flexibility of the hamstring muscle<sup>12</sup>. These impairments affect limb function and biomechanics of the gait<sup>13</sup>. The application of treatment to resolve this impairment is essential and should remain key interest to research<sup>14</sup>.

The hamstrings act as antagonists to the quadriceps in order to provide knee stability as well as to counteract anterior and rotational tibial shear forces during weight-bearing tasks<sup>15</sup>. Disruptions in hamstring strength,

flexibility, and morphology were associated with increased knee external rotation during jogging, patellar lateral tilt, patella–femoral joint stress, tendon overload, and linked to higher levels of pain and lower physical function<sup>16</sup>.

Quadriceps and Hamstring muscle strengthening are commonly recommended exercises for managing knee OA symptoms<sup>17</sup>. However, the effectiveness of these exercises in alleviating pain and improving functional ability remains unclear<sup>18</sup>. This study aims to investigate the comparative effectiveness of quadriceps muscle strengthening vs hamstring muscle strengthening in patients with knee OA<sup>19</sup>. By examining the outcomes of these two exercise approaches, this research seeks to provide evidence-based guidance for clinicians and patients, ultimately improving the management of knee OA<sup>20</sup>.

**Aim of the Study:** To compare the effectiveness of quadriceps muscle strengthening and hamstring muscle strengthening in improving pain, physical function, quality of life in patients with knee OA.

**Need of the study:** The need of the study on the effectiveness of quadriceps muscle strengthening vs. hamstring muscle strengthening in patients with knee OA arises from several clinical, scientific and practical considerations. This study lies in addressing the growing burden of knee OA, improving the effectiveness of non – pharmacological treatments, and filling critical gaps in the existing evidence. By comparing quadriceps and hamstring strengthening, research has potential to optimize exercise therapy protocols, enhance patient outcomes and

contribute to better clinical practice and guidelines.

## METHODOLOGY

A group of 30 participants on the bases of inclusion and exclusion criteria was selected and divided into two groups A and B. This Study design is Quasi Experimental, and comparative study (pre and post intervention) type. Sampling method is Random sampling and conducted at Dr. MGR. University, Faculty of Physiotherapy with sample size of 30. Outcome Measurements were Pain, Range of motion, and Function of knee. Measuring Tools are VAS (Visual analog scale), Goniometry, KOOS (knee Injury and Osteoarthritis outcome score). Outcome Measurements: Pain, Range of motion, Function of knee. Measuring Tools: VAS, Goniometry, KOOS (Knee injury and Osteoarthritis outcome score).

**Procedure:** A group of the 30 participant recruitment based on predefined inclusion and exclusion criteria. After obtaining informed consent, baseline assessments, including pain levels (VAS), functional status (KOOS), muscle strength, range of motion (Goniometry), and physical performance tests, will be conducted. Participants will be then randomly assigned into two groups: Group A (Quadriceps strengthening) and Group B (Hamstring strengthening).

A structured 6 weeks exercise intervention will be implemented, with sessions conducted 3 days per week. Each session will include warm – up, targeted strengthening exercises, and cool – down. Post – intervention assessment will be conducted to evaluate changes in pain, function, and strength, comparing outcomes between two groups.

## Group A

**Quadriceps Muscle Strengthening:** 15 members were given quadriceps muscle strengthening on knee pain, range of motion, and functions in patients with knee OA.

**1. Seated Knee Extension:** For the Seated Knee Extension exercise, have the patient sit upright on a firm chair with back support, ensuring their hips and knees are at 90 degrees of flexion and their feet are flat on the floor. The spine should remain neutral, and the arms should rest comfortably at the sides. The therapist should stand beside or in front of the patient to supervise, apply resistance at the ankle if needed, and monitor alignment and control throughout the exercise. To perform the movement, the patient should start by tightening the quadriceps, then fully extend the knee and hold the position for 2-3 seconds before slowly lowering the leg back down. The recommended routine is 10-15 repetitions for 2-3 sets. Progression can be achieved by adding ankle weights or resistance bands.

**2. Straight Leg Raises:** For the Straight Leg Raises exercise, the patient should lay supine on a firm surface with one leg bent and the foot flat on the floor, while the other leg remains straight. The spine should stay neutral, and the arms should be relaxed by the sides. The therapist should stand or sit beside the patient for supervision, providing cues for proper form and alignment, and applying gentle resistance at the ankle if needed. To perform the movement, the patient should start by tightening the quadriceps of the straight leg, then lift it until it reaches the height of the bent knee and hold for 2-3 seconds before slowly lowering it back down. The recommended routine is 10-15 repetitions

for 2-3 sets, and progression can be achieved by adding ankle weights.

**3. Wall Sit (isometric hold for 30 seconds):** For the Wall Sit exercise, the patient should stand with their back flat against a sturdy wall, feet hip-width apart and positioned 1-2 feet away from the wall to ensure that the knees do not extend past the toes during the exercise. The therapist should stand beside or in front of the patient for supervision and support, monitoring posture, knee alignment, and form throughout the exercise, and providing tactile cues or adjustments as needed. The patient should start by sliding down the wall until the knees are bent at 90 degrees or as tolerated, keeping the knees aligned directly over the ankles. After holding the position for 10-30 seconds, the patient should push through the heels to return to standing. The exercise should be performed for 2-3 sets of 10-30 second holds, with progression achieved by increasing the hold time or adding resistance.

**4. Step – ups on low platform:** For this Step-Up exercise, the patient should stand facing a stable platform 4-6 inches high with feet hip-width apart, maintaining an upright posture with shoulders back and core engaged. The therapist should stand beside or behind the patient to provide support and guidance, carefully monitoring knee alignment, posture, and control throughout the exercise. To perform the movement, the patient should start by placing one foot fully on the platform, then push through the heel to step up, bringing the other foot onto the platform. The patient should then step down slowly with the same leg and repeat the sequence with the other leg. The recommended routine is 10-12 repetitions per leg for 2-3 sets, with progression achieved by increasing the

platform height, adding weights, or using resistance bands.

**5. Mini Squat:** For this **Mini Squat** exercise, the patient should stand with feet hip-width apart and toes pointing forward, keeping the back straight, core engaged, and arms either extended forward or resting on the hips. The therapist should stand beside or behind the patient to provide support and supervision, carefully monitoring knee alignment and spine posture while offering tactile or verbal cues as needed. To perform the movement, the patient should start upright with knees slightly unlocked, then slowly bend the knees to a depth of 30 to 45 degrees while pushing the hips back and keeping the chest upright. The patient should then push through the heels to return to the starting position. The exercise should be performed for 10-15 repetitions, with progression achieved by increasing squat depth or adding resistance such as bands or weights.

## GROUP B

**Hamstring Muscle Strengthening:** 15 members will be given hamstring muscle strengthening on knee pain, range of motion, and functions in patients with knee OA

**1. Seated Hamstring Curls:** For the Seated Hamstring Curls exercise, the patient should sit upright on a sturdy chair with back support, knees bent at 90 degrees, and feet flat on the floor, maintaining a neutral spine with the core engaged. The therapist should stand beside or behind the patient to provide support and monitor form, offering resistance at the ankle if needed or adjusting the placement of the resistance band. To perform the exercise, the patient should start by securing a resistance

band around the ankle and the chair leg or using ankle weights, then pull the heel back toward the underside of the chair to engage the hamstrings. The patient should slowly return to the starting position. The recommended routine is 10-15 repetitions for 2-3 sets per leg, with progression achieved by increasing the resistance or the hold time as tolerated.

**2. Bridge Exercise:** For the Bridge Exercise, the patient should lie supine on a mat with knees bent and feet flat on the floor, hip-width apart, while keeping the arms resting by the sides with palms facing down, maintaining a neutral spine, and engaging the core. The therapist should stand beside or at the foot of the patient to monitor alignment, provide verbal or tactile cues, and assist with lifting or stabilizing the pelvis if needed. To perform the exercise, the patient should start by gently pressing the lower back into the mat, then push through the heels to lift the hips off the mat until a straight line is formed from the shoulders to the knees. The patient should then slowly lower the hips back to the starting position with control. The recommended routine is 10-15 repetitions for 2-3 sets, with progression achieved by adding resistance using a band around the thighs or placing a weight on the pelvis.

For the Standing Hamstring Curls exercise, the patient should stand upright with feet hip-width apart and knees slightly bent, holding onto a stable surface such as a chair or wall for balance. The therapist should stand beside or behind the patient to provide support and monitor form, applying resistance at the ankle if needed or adjusting the placement of a resistance band. To perform the exercise, the patient should start by engaging the core and

maintaining an upright posture, then flex the knee to bring the heel toward the buttocks without moving the thigh forward. The patient should lower the leg slowly back to the starting position. The recommended routine is 10-15 repetitions per leg for 2-3 sets, with progression achieved by adding ankle weights or resistance bands as tolerated.

**3. Swiss Ball Hamstring Curls:** For the **Swiss Ball Hamstring Curls**, the patient should lie supine on a mat with their legs straight and heels resting on a Swiss ball, keeping the arms by the sides with palms down for stability. The therapist should stand beside or behind the patient to provide support and guidance, carefully monitoring hip alignment and control throughout the exercise.

To perform the movement, the patient should start by engaging the core and lifting the hips off the mat to form a straight line from the shoulders to the heels. Then, the patient should bend the knees to roll the ball toward the glutes by pulling the heels in, and slowly extend the legs to roll the ball back to the starting position. The recommended routine is 10-15 repetitions for 2-3 sets, with progression achieved by performing single-leg curls or incorporating resistance bands.

**4. Good morning, Exercise:** For the **Good Morning Exercise**, the patient should stand with feet hip-width apart and knees slightly bent, placing their hands behind the head or holding a light barbell across the shoulders, while maintaining a neutral spine and engaged core. The therapist should stand beside or

behind the patient to provide support and correct form, carefully monitoring spinal alignment and the hip hinge technique. To perform the exercise, the patient should start by inhaling, engaging the core, and keeping the spine neutral, then hinge at the hips to lower the torso forward while keeping the back straight. The patient should then exhale and engage the glutes to return to the starting position. The recommended routine is 10-12 repetitions for 2-3 sets, with progression achieved by adding resistance using a barbell or resistance bands.

**Warm – up and Cool– down:** Each session will begin with 5 minutes of light aerobic activity and end with stretching exercises. After 6 weeks, reassess using outcome measures: Pain (VAS), Range of Motion (Goniometry), Function of knee (KOOS).

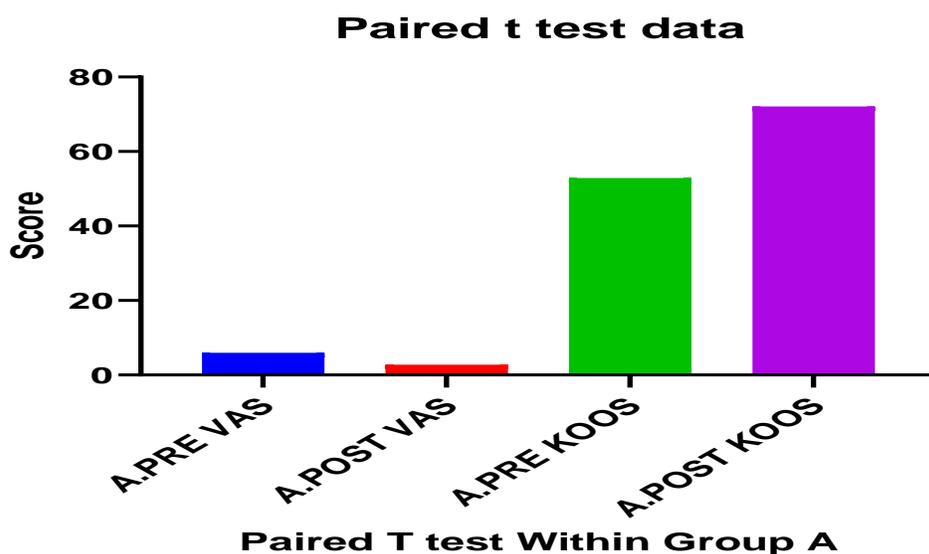
**Data Analysis:** The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using Graph Prism Pad version 8.4.3, with a significance level of p value less than 0.05 and a 95% confidence interval set for all analysis. The Shapiro Wilk test was used to determine the normality of the data. In this study, Shapiro Wilk test showed that the data was normally distributed on the dependent values at  $P > 0.05$ . Hence parametric test was adopted. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test (Student t-Test) was adopted to find statistical difference between the groups.

**Group A:**

**Table 1:** Paired t test within Group A on VAS and KOOS

Group A	Number of Pairs	Mean Diff.	SD, SEM	df	t	P value	Sig.Diff. (P < 0.05)
VAS	15	3.20	0.41 0.11	14	29.93	<0.0001	****
KOOS	15	19.20	1.94 0.50	14	38.44	<0.0001	****

The above table 1 shows significant difference in VAS and KOOS within Group A with P value <0.0001



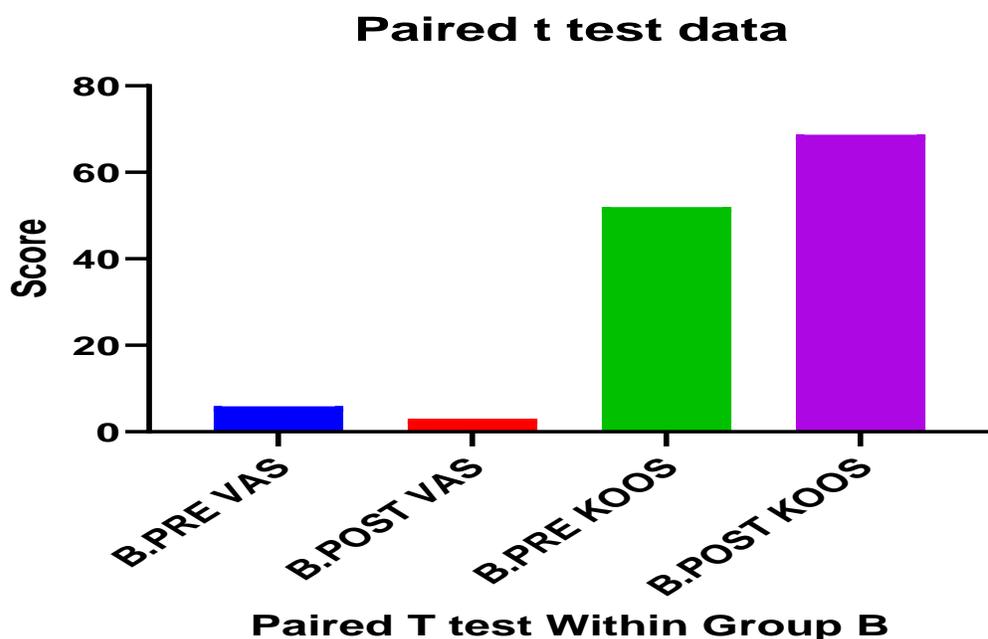
**Graph 1:** Presentation of VAS and KOOS within Group A

**Group B:**

**Table 2:** Paired t test within Group B on VAS and KOOS

Group B	Number of Pairs	Mean Diff.	SD, SEM	df	t	P value	Sig. Diff. (P < 0.05)
VAS	15	2.87	0.35 0.09	14	31.55	<0.0001	****
KOOS	15	16.73	1.87 0.48	14	34.66	<0.0001	****

The above table 2 shows significant difference in VAS and KOOS within Group B with P value <0.0001



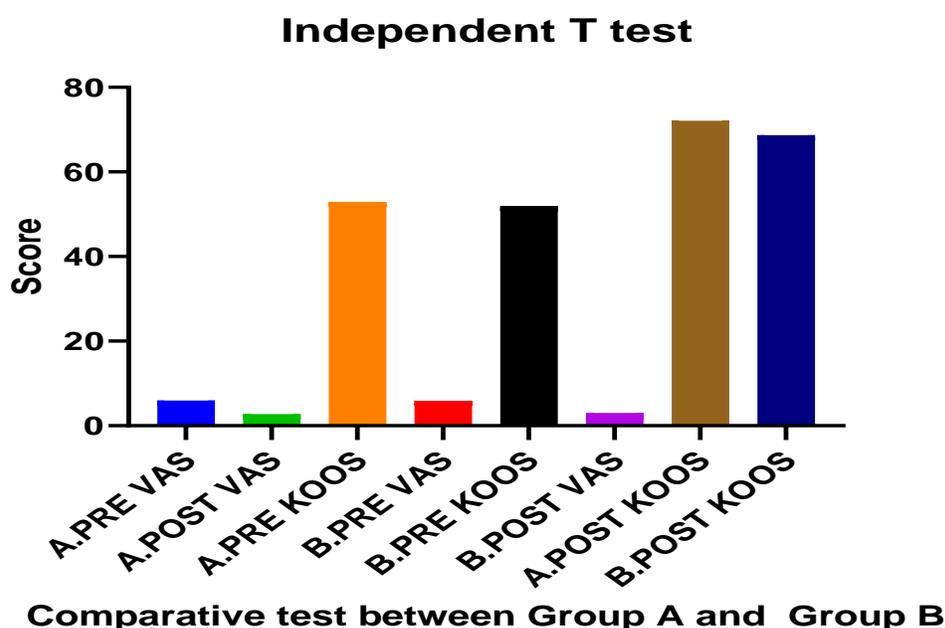
**Graph 2:** Presentation of VAS and KOOS within Group B

**Comparative Test between Group A and Group B**

**Table 3:** Independent t test between Group A and Group B

Group A&B		Number of Pairs	Mean Diff. ± SEM	R	DF	t	P value	Sig. Diff. (P < 0.05)
Pre test	VAS	30	0.06 0.28	0.00	28	0.24	0.81	NS
	KOOS	30	0.93 1.43	0.02	28	0.65	0.52	NS
Post test	VAS	30	2.73 0.03	0.03	28	1.00	0.33	NS
	KOOS	30	3.40 1.85	0.11	28	1.84	0.08	NS

The above table 3 shows NO significant difference on Pre Test of VAS and KOOS between Group A and Group B with P value 0.81 and 0.52, Post Test of VAS and KOOS between Group A and Group B, shows NO significance on P value with 0.33 and 0.08 respectively.



**Graph 3:** Presentation of VAS and KOOS between Group A and Group B

## RESULT

Total 30 participants, 13 male and 17 female subjects were included in the study based on specific selection criteria and divided in to 15 samples in each Group A and Group B. Participants were with age group between 46 and 60 years. In this study, the comparative effect of Group A over Group B on VAS and KOOS shows NO significant difference on Pre Test of VAS and KOOS between Group A and Group B with P value 0.81 and 0.52, Post Test of VAS and KOOS between Group A and Group B, shows NO significance on P value with 0.33 and 0.08 respectively.

Group A found effective on VAS and KOOS with mean score difference of 3.20 and 19.20 with P value <0.0001 respectively. Group B also found effective on VAS and KOOS with mean score difference of 2.87 and 16.73 with P value

<0.0001 respectively. Group A intervention found more effective over Group B intervention on VAS and KOOS with mean score difference of 3.20 and 19.20 over 2.87 and 16.73 respectively.

## DISCUSSION

Osteoarthritis (OA) of the knee is the most common form of joint disease. It is one of the major causes of impaired function that reduces quality of life. The purpose of the study is to compare the effectiveness of quadriceps muscle strengthening and hamstring muscle strengthening in patients with knee OA.

This study was aquasi-experimental comparative design with pre-test and post-test analysis conducted on 30 subjects diagnosed with Knee Osteoarthritis (OA). The subjects are divided into Group A and Group B, where

Quadriceps muscle strengthening exercises are given to Group A and Hamstring muscle strengthening exercises are given to Group B. Both interventions lasted for 6 weeks, and both group shows significant improvements in their respective outcomes.

In Group A (Quadriceps strengthening), the mean VAS score showed a reduction of 3.20 points, and KOOS improved by 19.20 points, both with a p-value < 0.0001, indicating high statistical significance. In Group B (Hamstring strengthening), the mean VAS score reduced by 2.87 points, and KOOS improved by 16.73 points, also with a p-value < 0.0001. Both groups show significantly improved after intervention but group A had slightly greater improvement in both pain and functional scores.

On comparing the pre-test and post-test intervention between the Group A and Group B, the pre-test revealed no significant difference between the two groups (VAS: p = 0.81; KOOS: p = 0.52), confirming that both groups were comparable at baseline, the post-test VAS difference between groups was 2.73 (p = 0.33), and the KOOS difference was 3.40 (p = 0.08). These findings suggest that Quadriceps muscle strengthening is more effective than Hamstring muscle strengthening.

The result of the study is consistent with previous literature. quadriceps strengthening exercises provided a sustainable improvement in functional abilities of Knee OA patients<sup>21</sup>. A future study with larger sample size is suggested to determine the optimal position for assessing knee JPS. These data imply that proprioception and endurance in people with KOA are two different and independent aspects of knee extensor muscle performance.

Thus, improving quadriceps endurance and proprioception may be suggested in managing individuals with KOA<sup>22</sup>.

The study is thereby designed on this basis, aiming to determine whether patients receiving quadriceps combined with hip abductor strengthening can attain more functional improvement, more pain relief and higher quality of life than those undergoing quadriceps strengthening alone<sup>23</sup>. Physiotherapy can develop strategies focused on lower limb strength training, with a greater emphasis on the quadriceps muscle, which is more compromised in this population, and on activities that aim at gait training, seeking a better distribution of body weight in both limbs and improvements of range of motion and muscle recruitment, thereby improving the performance of the individual during daily tasks and contributing to slow down the progression of OA<sup>24</sup>.

Strengthening of the quadriceps was shown to be beneficial for improving subjective knee pain, range of motion and decreasing the limitation of functional performance of patients with knee osteoarthritis. Therefore, while both interventions proved effective managing OA, Quadriceps muscle strengthening exercises demonstrate slightly effective. The study concludes that integrating Quadriceps muscle strengthening into routine care can enhance pain relief and functional activities for patients with Knee OA<sup>25</sup>.

**Ethical Clearance:** Ethical clearance has obtained from Faculty of Physiotherapy, Dr. MGR. Educational and Research Institute, Chennai, Tamil Nadu, India. Reference number: No: BPT IV Year-B Sec, 68/ PHYSIO/ IRB/ 2024-2025, dated: 16/12/ 2024.

**Conflict of interest:** There was no conflict of interest to conduct and publish this study.

**Fund for the study:** It was a self-financed study.

## CONCLUSION

The present study concludes that both quadriceps and hamstring muscle strengthening exercises are effective in reducing pain and improving functional outcomes in patients with knee osteoarthritis, as measured by VAS and KOOS scores.

While quadriceps strengthening (Group A) demonstrated slightly greater improvement in mean values compared to hamstring strengthening (Group B), the difference between the two groups was not statistically significant. This indicates that both interventions are beneficial and can be used in clinical practice based on individual patient needs and limitations. The results suggest that quadriceps strengthening or ideally, a combination of both can help enhance knee joint stability, reduce pain, and improve the quality of life in individuals with knee OA.

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